DATA SHEET

TDA8551
1 W BTL audio amplifier with digital volume control

Preliminary specification
File under Integrated Circuits, IC01

1997 May 07

Philips
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FEATURES

- One pin digital volume control
- Volume setting with UP/DOWN pulses
- Flexibility in use
- Few external components
- Low saturation voltage of output stage
- Stand-by mode controlled by CMOS compatible levels
- Low stand-by current
- No switch-on/switch-off plops
- High supply voltage ripple rejection
- Protected against electrostatic discharge
- Outputs short circuit safe to ground, V_P and across the load
- Thermally protected.

GENERAL DESCRIPTION

The TDA8551(T) is an one channel audio power amplifier for an output power of 1 W in an 8 Ω load at a 5 V supply. The circuit contains a BTL power amplifier, a digital volume control and stand-by/mute logic. The TDA8551T comes in an 8 pin SO package and the TDA8551 in a 8 pin DIP package.

APPLICATIONS

- Portable consumer products
- Personal computers
- Telephony.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_P	supply voltage		2.7	5	5.5	V
I_q	quiescent current	V_P = 5 V	–	8	10	mA
I_{stb}	stand-by current		–	–	10	μA
P_o	output power	THD = 10%; R_L = 8 Ω; V_P = 5 V	1	1.4	–	W
G_v	voltage gain		–60	–	+20	dB
n_{vol}	number of volume steps		–	64	–	
THD	total harmonic distortion	P_o = 0.5 W	–	0.15	–	%
SVRR	supply voltage ripple rejection		50	–	–	dB

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TDA8551T	SO8	plastic small outline package; 8 leads; body width 3.9 mm	SOT96-1
TDA8551	DIP8	plastic dual in-line package; 8 leads (300 mil)	SOT97-1

BLOCK DIAGRAM

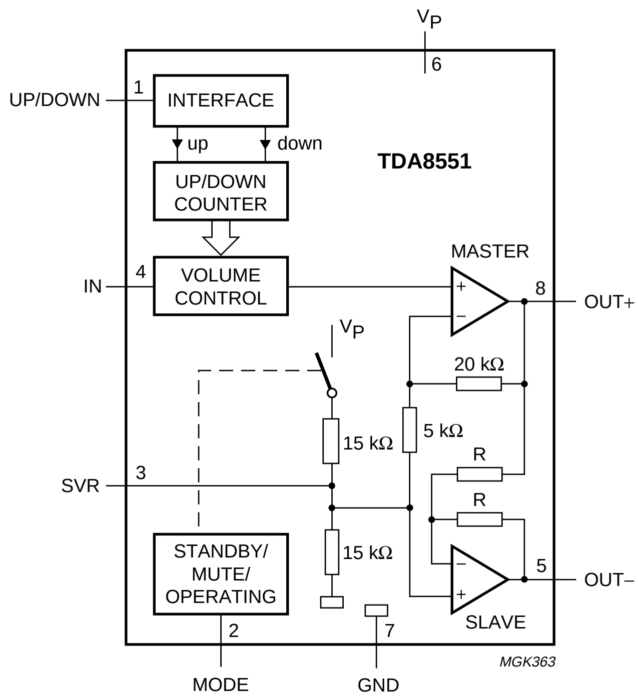


Fig.1 Block diagram.

PINNING

SYMBOL	PIN	DESCRIPTION
UP/DOWN	1	digital trinary input for volume control
MODE	2	digital trinary input for mode selection (standby, mute, operating)
SVR	3	half supply voltage, decoupling ripple rejection
IN	4	audio input
OUT–	5	negative loudspeaker terminal
V_P	6	supply voltage
GND	7	ground
OUT+	8	positive loudspeaker terminal

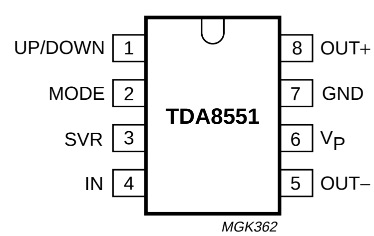


Fig.2 Pin configuration.

FUNCTIONAL DESCRIPTION

The TDA8551(T) is a 1 W BTL audio power amplifier capable of delivering 1 W output power to an 8 Ω load at THD = 10% using a 5 V power supply. The gain of the amplifier can be set by the digital volume control. In the maximum volume setting the gain is 20 dB. By the MODE pin the device can be switched to the stand-by condition, the mute condition and the normal operating condition. The device is protected by an internal thermal shutdown protection mechanism.

Power amplifier

The power amplifier is a Bridge Tied Load (BTL) amplifier with a complementary CMOS output stage. The total voltage loss for both output power MOS transistors is within 1 V and with an 5 V supply and an 8 Ω loudspeaker an output power of 1 W can be delivered. The total gain of this power amplifier is internally fixed at 20 dB.

Volume control

The volume control operates as a digital controlled attenuator between the audio input pin and the power amplifier. In the maximum volume control setting the attenuation is 0 dB and in the minimum volume control setting the typical attenuation is 80 dB. The attenuation can be set in 64 steps by the UP/DOWN pin. This UP/DOWN pin is a trinary input:

- Floating UP/DOWN pin: volume remains unchanged
- Negative pulses: setting volume towards minimum
- Positive pulses: setting volume towards maximum.

Each pulse on the UP/DOWN pin results in a change in gain of 80/64 = 1.25 dB (typical value). In the basic application the UP/DOWN pin is switched to ground or V_P by a double push-button. When the supply voltage is initially connected, after a complete removal of the supply, the initial state of the volume control is an attenuation of 40 dB (low volume), so the gain of the total amplifier is –20 dB. After powering-up, some positive pulses have to be applied to the UP/DOWN pin for turning up to listening volume. When the device is switched with the MODE select pin to the mute- or the standby condition, the volume control attenuation setting remains on its value, under the assumption that the voltage on the V_P pin not falls below the minimum supply voltage. After switching the device back to the operation mode, the previous volume setting is maintained.

Mode select pin

The device is in the stand-by mode (with a very low current consumption) if the voltage at the MODE pin is between V_P and V_P – 0.5 V. At a mode select voltage level of less than 0.5 V the amplifier is fully operational. In the range between 1 V and V_P – 1.4 V the amplifier is in the mute condition. The mute condition is useful for using it as a ‘fast mute’, in this mode output signal is suppressed, while the volume setting remains at its value. It is advised to keep the device in the mute condition while the input capacitor is being charged. This can be done by holding the MODE pin at a level of $0.5V_P$, or by waiting approx. 100 ms before giving the first volume-UP pulses.

LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_P	supply voltage		–0.3	+5.5	V
V_I	input voltage		–0.3	V_P + 0.3	V
I_{ORM}	repetitive peak output current		–	1	A
T_{stg}	storage temperature		–55	+150	°C
T_{amb}	operating temperature		–40	+85	°C
V_{sc}	AC and DC short-circuit safe voltage		–	5.5	V
P_{tot}	maximum power dissipation	SO8	–	0.8	W
		DIP8	–	1.2	W

QUALITY SPECIFICATION

Quality according to *“SNW-FQ-611 part E”*, if this type is used as an audio amplifier. Quality specifications are listed in the *“Quality reference handbook”*, order number 9397 750 00192.

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th\ j\text{-}a}$	thermal resistance from junction to ambient	in free air		
	SO8		160	K/W
	DIP8		100	K/W

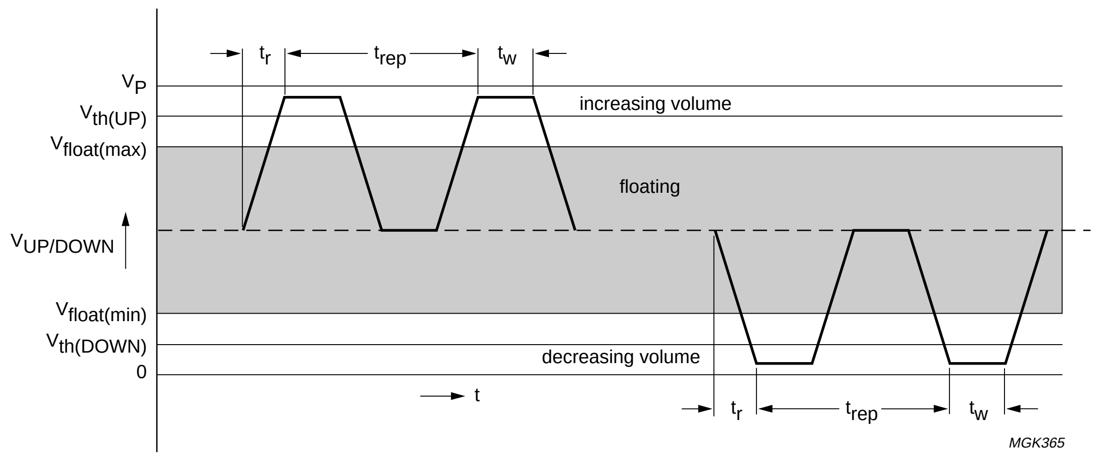
CHARACTERISTICS

V_P = 5 V; T_{amb} = 25 °C; R_L = 8 Ω; V_{MODE} = 0 V; total gain setting at +7 dB (unless otherwise specified); measured in Fig.4.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
DC Characteristics						
V_P	supply voltage		2.7	5	5.5	V
I_q	quiescent current	$R_L = \infty$; note 1	–	8	10	mA
I_{stb}	stand-by current	$V_{MODE} = V_P$	–	–	10	μA
V_O	DC output voltage	note 2	–	2.5	–	V
$\lvert V_{OUT+} - V_{OUT-} \rvert$	differential output offset		–	–	50	mV
$I_{i(bias)}$	input bias current		–	–	tbf	nA
Mode select pin						
V_{MODE}	input voltage	standby	$V_P - 0.5$	–	V_P	V
		mute	1	–	$V_P - 1.4$	V
		operating	0	–	0.5	V
I_{MODE}	input current	$0 < V_{MODE} < V_P$	–	–	100	nA
α	mute attenuation	note 3	80	tbf	–	dB
Volume control						
t_{rep}	pulse repetition time		100	–	–	ns
$V_{th(UP)}$	UP/DOWN pin **up** threshold level		4.1	–	V_P	V
$V_{float(max)}$	UP/DOWN pin floating high level		–	–	3.4	V
$V_{float(min)}$	UP/DOWN pin floating low level		1.0	–	–	V
$V_{th(DOWN)}$	UP/DOWN pin **down** threshold level		0	–	0.6	V
$I_{UP/DOWN}$	current UP/DOWN pin	$0 < V_{UP/DOWN} < V_P$	–	–	200	μA
$G_{v(max)}$	maximum voltage gain (including power amplifier)		19	20	21	dB
$G_{v(min)}$	minimum voltage gain (including power amplifier)		tbf	–60	tbf	dB
n_{vol}	number of volume steps		–	64	–	
ΔG_v	voltage gain variation per step		–	1.25	–	dB
Z_i	input impedance		14	20	–	kΩ
$V_{i(rms)(max)}$	maximum input voltage (RMS value)		–	–	2.0	V
AC Characteristics (f = 1 kHz)						
P_o	output power	THD = 10%	1	1.4	–	W
		THD = 0.5%	0.6	1.0	–	W
THD	total harmonic distortion	P_o = 0.5 W	–	0.15	0.5	%
		P_o = 0.1 W	–	0.1	0.3	%
V_{no}	noise output voltage	note 4	–	60	100	μV
SVRR	supply voltage ripple rejection	note 5	48	53	–	dB
$V_{i(max)}$	maximum input voltage	THD = 1%; G_v = –50 dB up to 0 dB	–	–	2.0	V

Notes to the characteristics

1. With a load connected at the outputs the quiescent current will increase, the maximum of this increase being equal to the DC output offset voltage divided by R_L.
2. The DC output voltage with respect to ground is approximately $0.5V_P$.
3. Output voltage in mute position is measured with an input of 1 V (RMS), including noise, in a bandwidth of 20 kHz.
4. The noise output voltage is measured at the output in a frequency band from 20 Hz to 20 kHz (unweighted), input source impedance R_{source} = 0 Ω.
5. Supply voltage ripple rejection is measured at the output, with a source impedance of R_{source} = 0 Ω at the input. The ripple voltage is a sine wave with frequency of 1 kHz and an amplitude of 100 mV (RMS) is applied to the positive supply rail.



The rise time (t_r) and the width of the pulse (t_w) are not critical.

Fig.3 Timing UP/DOWN pin.

TEST AND APPLICATION INFORMATION

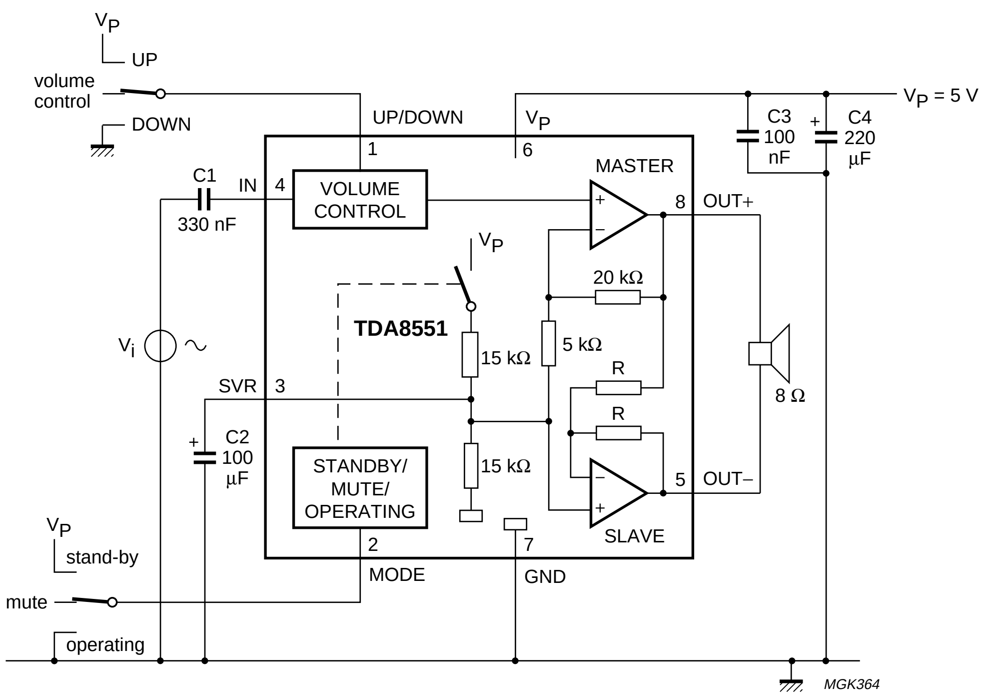
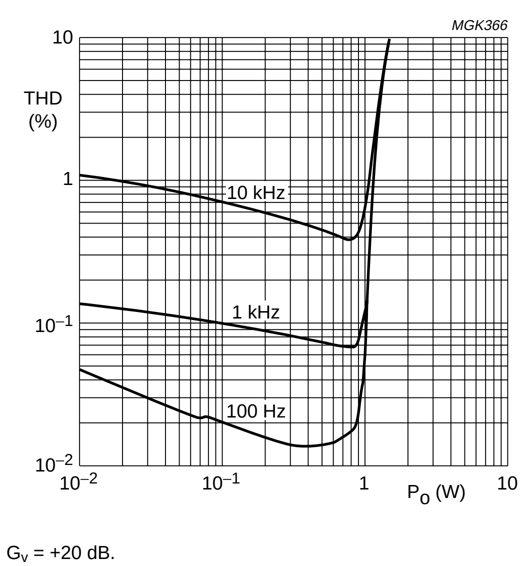


Fig.4 Test and application circuit.



G_v = +20 dB.

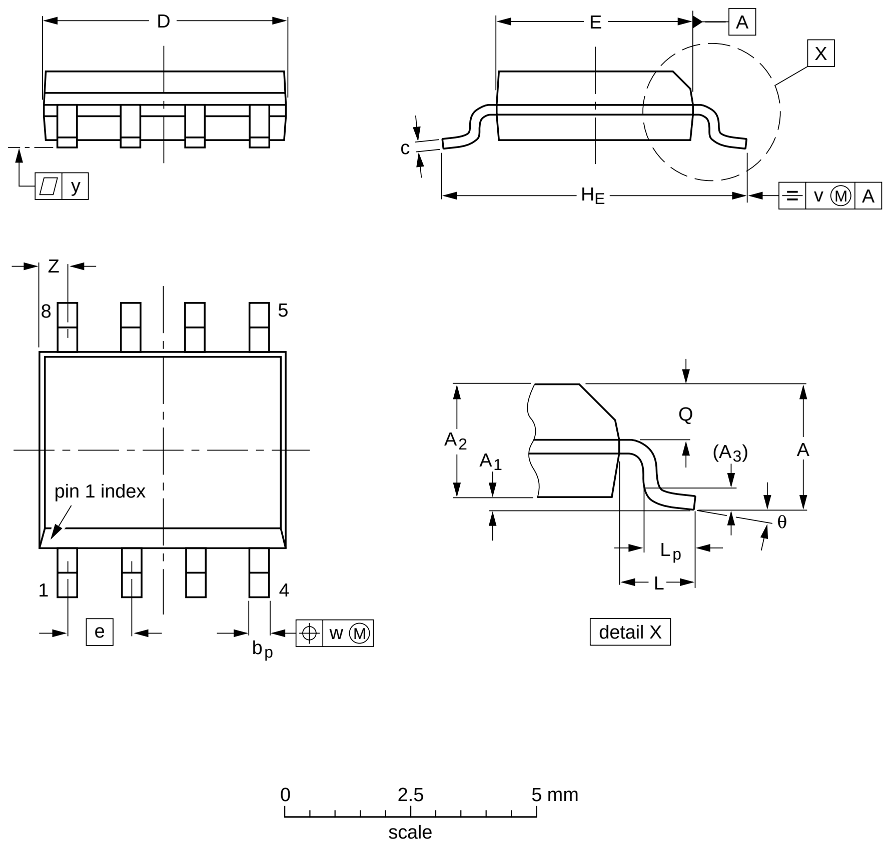
Fig.5 Total harmonic distortion as function of output power.

Reduction of the value of capacitor C2 results in a decrease of the SVRR performance at low frequencies.

The UP/DOWN pin can be driven by a 3-state logic output stage (microcontroller) without extra external components. If the UP/DOWN pin is driven by push-buttons, then it is advised to have an RC-filter between the buttons and the UP/DOWN pin. Advised values for the RC-filter are 2.2 kΩ and 100 nF.

PACKAGE OUTLINES

SO8: plastic small outline package; 8 leads; body width 3.9 mm SOT96-1



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

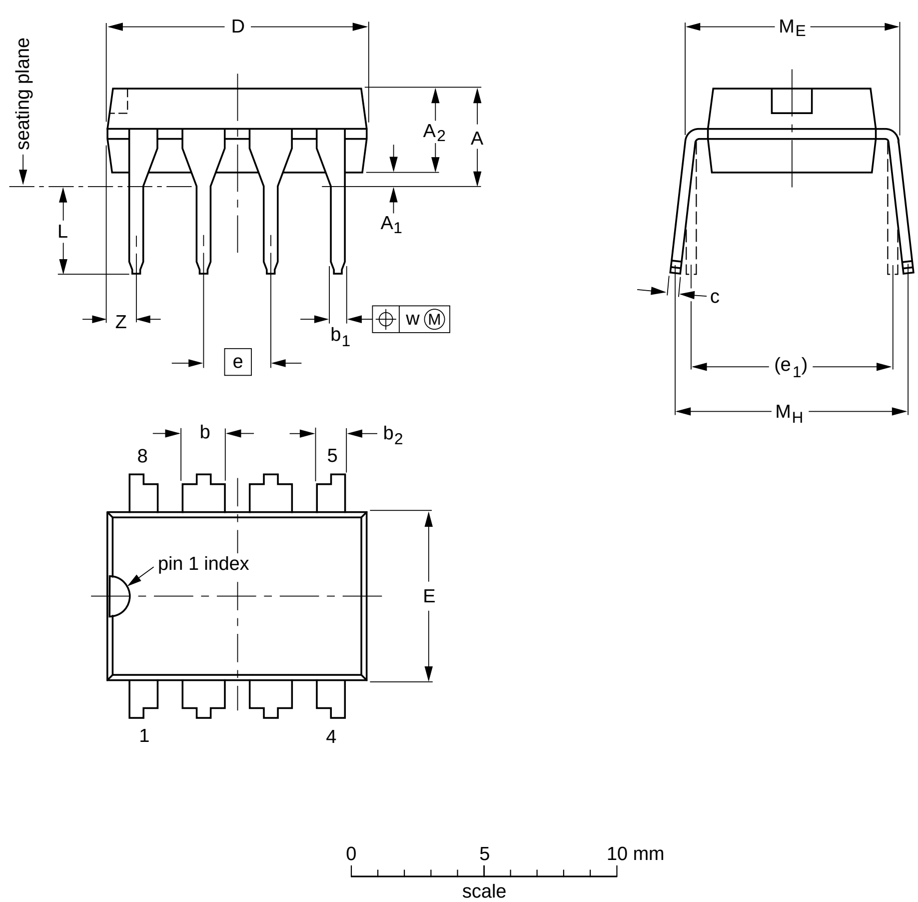
UNIT	A max.	A_1	A_2	A_3	b_p	c	D(1)	E(2)	e	H_E	L	L_p	Q	v	w	y	Z(1)	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	5.0 4.8	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8^o 0^o
inches	0.069	0.010 0.004	0.057 0.049	0.01	0.019 0.014	0.0100 0.0075	0.20 0.19	0.16 0.15	0.050	0.244 0.228	0.041	0.039 0.016	0.028 0.024	0.01	0.01	0.004	0.028 0.012	

Notes

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT96-1	076E03S	MS-012AA				~~95-02-04~~ 97-05-22

DIP8: plastic dual in-line package; 8 leads (300 mil) **SOT97-1**



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A_1 min.	A_2 max.	b	b_1	b_2	c	D (1)	E (1)	e	e_1	L	M_E	M_H	w	Z (1) max.
mm	4.2	0.51	3.2	1.73 1.14	0.53 0.38	1.07 0.89	0.36 0.23	9.8 9.2	6.48 6.20	2.54	7.62	3.60 3.05	8.25 7.80	10.0 8.3	0.254	1.15
inches	0.17	0.020	0.13	0.068 0.045	0.021 0.015	0.042 0.035	0.014 0.009	0.39 0.36	0.26 0.24	0.10	0.30	0.14 0.12	0.32 0.31	0.39 0.33	0.01	0.045

Note

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT97-1	050G01	MO-001AN				~~92-11-17~~ 95-02-04

SOLDERING

Introduction

There is no soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and surface mounted components are mixed on one printed-circuit board. However, wave soldering is not always suitable for surface mounted ICs, or for printed-circuits with high population densities. In these situations reflow soldering is often used.

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our *"IC Package Databook"* (order code 9398 652 90011).

DIP

SOLDERING BY DIPPING OR BY WAVE

The maximum permissible temperature of the solder is 260 °C; solder at this temperature must not be in contact with the joint for more than 5 seconds. The total contact time of successive solder waves must not exceed 5 seconds.

The device may be mounted up to the seating plane, but the temperature of the plastic body must not exceed the specified maximum storage temperature ($T_{stg\ max}$). If the printed-circuit board has been pre-heated, forced cooling may be necessary immediately after soldering to keep the temperature within the permissible limit.

REPAIRING SOLDERED JOINTS

Apply a low voltage soldering iron (less than 24 V) to the lead(s) of the package, below the seating plane or not more than 2 mm above it. If the temperature of the soldering iron bit is less than 300 °C it may remain in contact for up to 10 seconds. If the bit temperature is between 300 and 400 °C, contact may be up to 5 seconds.

SO

REFLOW SOLDERING

Reflow soldering techniques are suitable for all SO packages.

Reflow soldering requires solder paste (a suspension of fine solder particles, flux and binding agent) to be applied to the printed-circuit board by screen printing, stencilling or pressure-syringe dispensing before package placement.

Several techniques exist for reflowing; for example, thermal conduction by heated belt. Dwell times vary between 50 and 300 seconds depending on heating method. Typical reflow temperatures range from 215 to 250 °C.

Preheating is necessary to dry the paste and evaporate the binding agent. Preheating duration: 45 minutes at 45 °C.

WAVE SOLDERING

Wave soldering techniques can be used for all SO packages if the following conditions are observed:

- A double-wave (a turbulent wave with high upward pressure followed by a smooth laminar wave) soldering technique should be used.
- The longitudinal axis of the package footprint must be parallel to the solder flow.
- The package footprint must incorporate solder thieves at the downstream end.

During placement and before soldering, the package must be fixed with a droplet of adhesive. The adhesive can be applied by screen printing, pin transfer or syringe dispensing. The package can be soldered after the adhesive is cured.

Maximum permissible solder temperature is 260 °C, and maximum duration of package immersion in solder is 10 seconds, if cooled to less than 150 °C within 6 seconds. Typical dwell time is 4 seconds at 250 °C.

A mildly-activated flux will eliminate the need for removal of corrosive residues in most applications.

REPAIRING SOLDERED JOINTS

Fix the component by first soldering two diagonally-opposite end leads. Use only a low voltage soldering iron (less than 24 V) applied to the flat part of the lead. Contact time must be limited to 10 seconds at up to 300 °C. When using a dedicated tool, all other leads can be soldered in one operation within 2 to 5 seconds between 270 and 320 °C.

DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.

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